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SNOWMELT RUNOFF FROM PLANTED CONIFERS IN SOUTHWESTERN WISCONSIN

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ABSTRACT.--Snowmelt overland flow was measured for one season from 10-year-old plantations of red pine, Norway spruce, European larch, and from old field control plots, on both north and south slopes. Pine and spruce plots produced more runoff than larch and old field plots; and south slope plots produced more runoff than north slope plots.
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Snowmelt runoff from frozen ground is the primary cause of spring floods in southwestern Wisconsin's unglaciated region. Natural deciduous forests rarely contribute, probably because of discontinuous or more permeable frost in the forest.[1/] However, because coniferous forests insulate the ground better than deciduous forests, they may retain frost in the spring longer than open land, and thus produce more runoff from melting snow than open land.[2/] [3/] If this is true, extensive planting of conifers could worsen floods in the region. This note reports on a study conducted to determine if planted conifer stands produce more snowmelt runoff than natural deciduous forests.

METHODS

The study was conducted on the Coulee Experimental Forest near La Crosse, Wisconsin on plantations established specifically for the purpose. Three species were studied: red pine (*Pinus resinosa* Ait.), Norway spruce (*Picea abies* L. Karst.), and European larch (*Larix decidua* Mill.). The trees were planted in 1964 and 1965 at a spacing of 2 by 2 m on 0.2 h plots. The three species were planted in four blocks, two each on opposite north- and south-facing slopes of 15 to 20 percent. Each block consisted of a 500-tree plot of each species and an unplanted control plot of the same size. The study area had been an alfalfa meadow or old field. The trees were hand-planted in scalps to avoid the influence of planting furrows on overland flow. The soil is an eroded loessal silt loam of the Fayette series (valley phase).

Overland flow from 4-by 8-m runoff subplots made of redwood borders and catchment troughs was monitored during snowmelt in 1975. The runoff water was piped to collecting tanks. One runoff subplot was centered in each planted and control plot (16 in all). Water caught in the troughs and tanks was kept from freezing by electric heat tapes. The tanks were measured and then emptied six times during the snowmelt period.

1/ *Richard S. Sartz, Willie R. Curtis, and David N. Tolsted. Hydrology of small watersheds in Wisconsin's Driftless Area. (Manuscript in process for publication.)*

2/ *Alfred Ray Harris. Infiltration rate as affected by soil freezing under three cover types. Soil Sci. Soc. Am. Proc. 36:489-492. 1972.*

3/ *Richard S. Sartz. Influence of land use on time of soil freezing and thawing in the Northeast. J. For. 55:716-718. 1957.*

Snow and frost depth were measured at three points 5 m apart on each plot at the beginning of the runoff period. Measuring points on planted plots were midway between rows of trees. Frost depth was measured by modified Gondahl frost depth gages.[4/]

By 1975, the 10th year after planting, the pine and spruce were 3 to 4 m tall, and the larch were about 5 m tall. The larch canopy was closed, and the pine and spruce canopies were almost closed. The soil was almost completely covered with needles, mosses, and dead herbaceous growth on all plots, but the heaviest cover was formed by matted grass on the unplanted control plots.

RESULTS AND DISCUSSION

At the beginning of the 1975 snowmelt period the average depth of the snowpack was 30 cm on south slope plots and 50 cm on north slope plots. Corresponding water equivalents were about 9 and 15 cm, based on snow density data from elsewhere on the experimental forest. The snowpack started melting about the middle of March. Most south slope plots were bare by April 7, but north slope plots still had a continuous snow cover--up to 40 cm deep in spots. The last snowmelt runoff was measured on April 16, at which time small patches of snow still remained on north-facing plots. Snow depth and rate of melt on individual plots varied with aspect, which ranged from 31° E to 43° W on south aspects, and from 52° E to 37° W on north aspects.

Pine and spruce plots produced much more runoff than larch and unplanted plots, and south slope plots produced more than north slope plots. Total snowmelt runoff from March 18 to April 16 was as follows:

	South-slope plot	*North-slope plot*
	(In cm)	
Pine	2.9[5/]	2.8
Spruce	4.0	2.4
Larch	1.2	0.1
Unplanted	1.3	0.3

Although the amount of runoff varied widely between replicates, runoff from the pine and spruce and the larch and unplanted were different (table 1). Expressed as a percent of the water content of the snowpack, runoff from south slope plots ranged from 14 to 42 percent, and from north slope plots, from 0.5 to 20 percent. Even with much more snow on the ground, north slope plots produced less runoff.

Table 1.--*Snowmelt runoff on individual plots, March 18 to April 16, 1975*
(In centimeters)

Plot	Pine	Spruce	Larch	Unplanted
	SOUTH			
1	1/ 3.46	1/ 3.42	1.32	1.02
2	2.24	1/ 4.62	1.18	1.60
Mean	1/ 2.85	1/ 4.02	1.25	1.31
	NORTH			
1	2.12	0.39	0.06	0.23
2	1/ 3.48	1/ 4.40	.08	.38
Mean	1/ 2.80	1/ 2.40	.07	.30

1/ Estimated. Runoff tanks overflowed.

Most of the runoff from both slopes occurred during the period from March 18 to 24. However, the proportion measured on the first and last days of record was different on the two slopes (table 2).

Table 2.--*Early and late runoff from pine and spruce plots*[1/]
(In percent of total)

Date measured:	South slope: Pine	South slope: Spruce	North slope: Pine	North slope: Spruce
March 18	20	26	9	5
April 16	10	3	27	17

1/ Means of two plots.

Frost incidence and depth as measured did not fully explain runoff differences. Frost was found at all three points only on one pine and one open plot; and none of the three sampling points was frozen on four of the eight spruce or pine plots. However, the measured frost values (taken at points midway between trees) probably did not reflect actual frost conditions under the canopies of the pines and spruces. Uneven distribution of snow caused by irregular shading and by interception and subsequent canopy dumping could have caused runoff differences between the pine and spruce plots, and the larch and open plots. Accumulation of ice on the soil surface from canopy drip could also explain the differences.[2/]

The results of this study support Harris' conclusion that planting pine and spruce can increase snowmelt runoff in the unglaciated area. They also show that where flood prevention is an important consideration in tree planting programs, larch should be favored over pine or spruce.

4/ *Alfred Ray Harris. Direct reading frost gage is reliable, inexpensive. USDA For. Serv. Res. Note NC-89, 2 p. North Cent. For. Exp. Stn., St. Paul, Minn. 1970.*

5/ *Values are means of two plots.*

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